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मानक

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Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

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IS 15927-3 (2011): Polyethylene Fittings for use with Polyethylene Pipes for the Supply of Gaseous Fuels, Part 3: Electro Fusion Fittings [CED 50: Plastic Piping System]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

गैसीय ईंधन की पूर्ति के लिए पालीईथाइलीन पाइपों के
साथ प्रयोग के लिए पालीईथाइलीन फिटिंगें — विशिष्टि

भाग 3 इलेक्ट्रो फ्यूजन फिटिंगें

Indian Standard

POLYETHYLENE FITTINGS FOR USE WITH
POLYETHYLENE PIPES FOR THE SUPPLY OF
GASEOUS FUELS — SPECIFICATION

PART 3 ELECTRO FUSION FITTINGS

ICS 75.200; 83.140.30

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Part 3) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastic Piping Systems Sectional Committee had been approved by the Civil Engineering Division Council.

The requirements for polyethylene fittings for use with polyethylene pipes for supply of gaseous fuels are covered by three parts. The other parts in the series are:

- Part 1 Fitting for socket fusion using heated tools
- Part 2 Spigot fittings for butt fusion, for socket fusion using heated tools and for use with electro fusion fittings

This standard covers polyethylene electro fusion fittings in the nominal sizes 16 mm to 315 mm inclusive, where the sizes indicate compatibility of fitting with polyethylene pipes of the corresponding size in accordance with IS 14885 : 2001 'Polyethylene pipes for the supply of gaseous fuels — Specification'.

In the formulation of this standard considerable assistance has been derived from ISO 8085-3 : 2001 'Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specification: Part 3 Electro fusion fittings'.

This standard does not purport to address all the safety requirements associated with the use of these fittings. It is the responsibility of users to establish safety and health practices. Regulatory norms associated with the product are to be adhered to.

The composition of the Committee responsible for the formulation of this standard is given in Annex M.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the results of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

POLYETHYLENE FITTINGS FOR USE WITH POLYETHYLENE PIPES FOR THE SUPPLY OF GASEOUS FUELS — SPECIFICATION

PART 3 ELECTRO FUSION FITTINGS

1 SCOPE

This standard (Part 3) lays down requirements for buried polyethylene electro fusion fittings incorporating integral heating element(s) where the shape and composition of the fitting is suitable for fusion with polyethylene pipe complying with IS 14885 and fittings conforming to Part 2 of this standard, for the supply of gaseous fuels for nominal outside diameters ranging from 16 mm to 315 mm, SDR 11 and SDR 17.6, material grades PE 80 and PE 100, pressures 5.5 bar (*see* Note) and 7 bars and operating temperatures from -5°C to 40°C .

NOTE — 1 bar = $10^5 \text{ N/m}^2 = 0.1 \text{ MPa}$.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
2530 : 1963	Method of test for polyethylene moulding materials and polyethylene compound
4905 : 1968	Methods for random sampling
7328 : 1992	High density polyethylene materials for moulding and extrusion — Specification (<i>first revision</i>)
14885 : 2001	Polyethylene pipes the supply of gaseous fuels — Specification
15430 : 2003	Rubber seals — Joint rings used for gas supply pipes and fittings — Specification for material
15927	Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Specification:
(Part 1) : 2011	Fittings for socket fusion using heated tools

IS No.

Title

(Part 2) : 2011 Spigot fittings for butt fusion for socket fusion using heated tools and for use with electro fusion fittings

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

3.1 Nominal Diameter of Fitting (d_n) — The nominal diameter of a fitting is taken as the nominal diameter of the corresponding pipe series.

3.2 Nominal Wall Thickness of Fitting (e_n) — The nominal wall thickness of a fitting is taken as the nominal wall thickness of the corresponding pipe series.

3.3 Mean Outside Diameter — Arithmetic mean of a number of measurements of the outer circumference of the tubular part of the fitting in any cross section, divided by π (3.1416) and rounded up to the nearest 0.1mm.

3.4 Out of Roundness (Ovality) — Maximum outside diameter minus the minimum outside diameter of the fitting measured in the same plane, parallel to the plane of the mouth.

3.5 Standard Dimension Ratio of Fitting (SDR) — The SDR value of a fitting is taken as quotient of the nominal out side diameter and the nominal wall thickness of the corresponding pipe (expressed rounded to one decimal) and is given by:

$$SDR = \frac{d_n}{e_n}$$

3.6 Wall Thickness of Fitting (E) — Wall thickness at any point of the body of the fitting, which could be submitted to the full stress induced by the pressure of the gas in the piping system.

3.7 Melt Flow Rate (MFR) — Value relating to the viscosity of the molten thermoplastic material at a specified temperature and rate of shear.

3.8 Maximum Allowable Operating Pressure (MAOP) — The highest effective pressure of the gas in the piping system expressed in bar, which is allowable in continuous use. It takes into account the physical and the mechanical characteristics of the components of piping system. It is given by the equation:

$$MAOP = \frac{20 MRS}{C (SDR - 1)}$$

3.9 Overall Service (Design) Coefficient (C) — An overall coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit. For gas applications, C can have any value equal to or greater than 2.0.

3.10 Gaseous Fuel — Any fuel which is in the gaseous state at a temperature of +15°C and a pressure of 1 bar.

3.11 Virgin Material — Thermoplastics material in a form such as granules which has not been previously processed other than for compounding and to which no reprocessible or recyclable materials have been added.

3.12 Compound — Homogeneous mixture of base polymer (PE) and additives, for example anti-oxidants, pigments and U.V. stabilizers at concentrations necessary for the particular application.

3.13 Lower Confidence Limit (σ_{LCI}) — Quantity with the dimensions of stress, in MPa, which can be considered as a property of the material and represents the 97.5 percent lower confidence limit of the mean long-term hydrostatic strength at 20°C for 50 years determined by pressurizing internally with water.

3.14 Minimum Required Strength (MRS) — Minimum value, in MPa, for long term hydrostatic strength (LTHS) of the material.

3.15 Branch Saddle — An electro fusion saddle fitting for branch tapping, but not containing integral cutter which uses ancillary cutters for drilling hole in the main.

3.16 Elbow — A curved cylinder enabling a change of direction with a maximum centre line radius of 1 time nominal bore.

3.17 Flange Adapter — A spigot end fitting used with a seal/gasket and slip-on backing flange for making a detachable joint in a PE system.

3.18 Inner Cold Zone — Distance between the end of a fusion coil and the pipe penetration stop of a socket fitting.

3.19 Electro Fusion Tapping Tee — An electro fusion saddle fitting having a single heating element which shall be assembled on the pipe with a top load or with a wrap around clamp and shall contain an integral cutter which remains in the body of the fitting after installation.

3.20 Electro Fusion Saddle — An electro fusion saddle fitting (top loading or wrap around) which contains one or more integral heating element(s).

3.21 Cutter — A cutting device used in electro fusion tapping tee for cutting the mains pipe to enable a tapping.

3.22 Spigot — A spigot is the outlet of electro fusion tapping tee or a branch tee having its diameter equal to the nominal diameter of the corresponding pipe used to connect to service pipe.

3.23 Electro Fusion Socket Fitting — A fitting with one or more cylindrical sockets into which pipes or fitting spigots can be inserted to form an assembly for subsequent jointing by electro fusion and creation of an integral pipe/fitting connection.

3.24 Cap — A cap is a cover used to close the electro fusion tapping tee top.

3.25 Coupler — A straight socketed fitting to join two pipes of the same size.

3.26 Internal Diameter (d_s) — It is the specified nominal internal diameter of the socket, expressed in millimetre (mm).

3.27 Reducer — A socketed fitting to join two pipes with different nominal diameters.

3.28 Heating Element — A resistance wire used to heat the surface of fitting and pipe to establish a fusion joint.

4 SYMBOLS

4.1 Electro Fusion Socket Fittings

The dimensions and symbols used in standard part are shown in Fig. 1A.

4.2 Electro Fusion Tapping Tees

The dimensions and symbols used in standard part are shown in Fig. 1B.

5 DESIGNATION

5.1 Fittings shall be designated according to the grade of material used (*see 5.2*), nominal diameter (*see 9*) and standard dimension ratio (SDR) (*see 3.5*). For example, PE-80 DN90 SDR 11 indicates that the fitting is made from the material grade PE-80, of nominal diameter 90 mm having SDR 11 rating.

5.2 Grade of Material

5.2.1 Fittings shall be classified according to the grade of material as given in Table 1 of IS 14885.

5.2.2 The maximum allowable hydrostatic design stress (σ) of a fitting is obtained by applying the design safety coefficient of 2.0 minimum at 20°C to the MRS value of the material.

5.2.3 The raw material supplier shall provide the material grading.

5.3 Colour

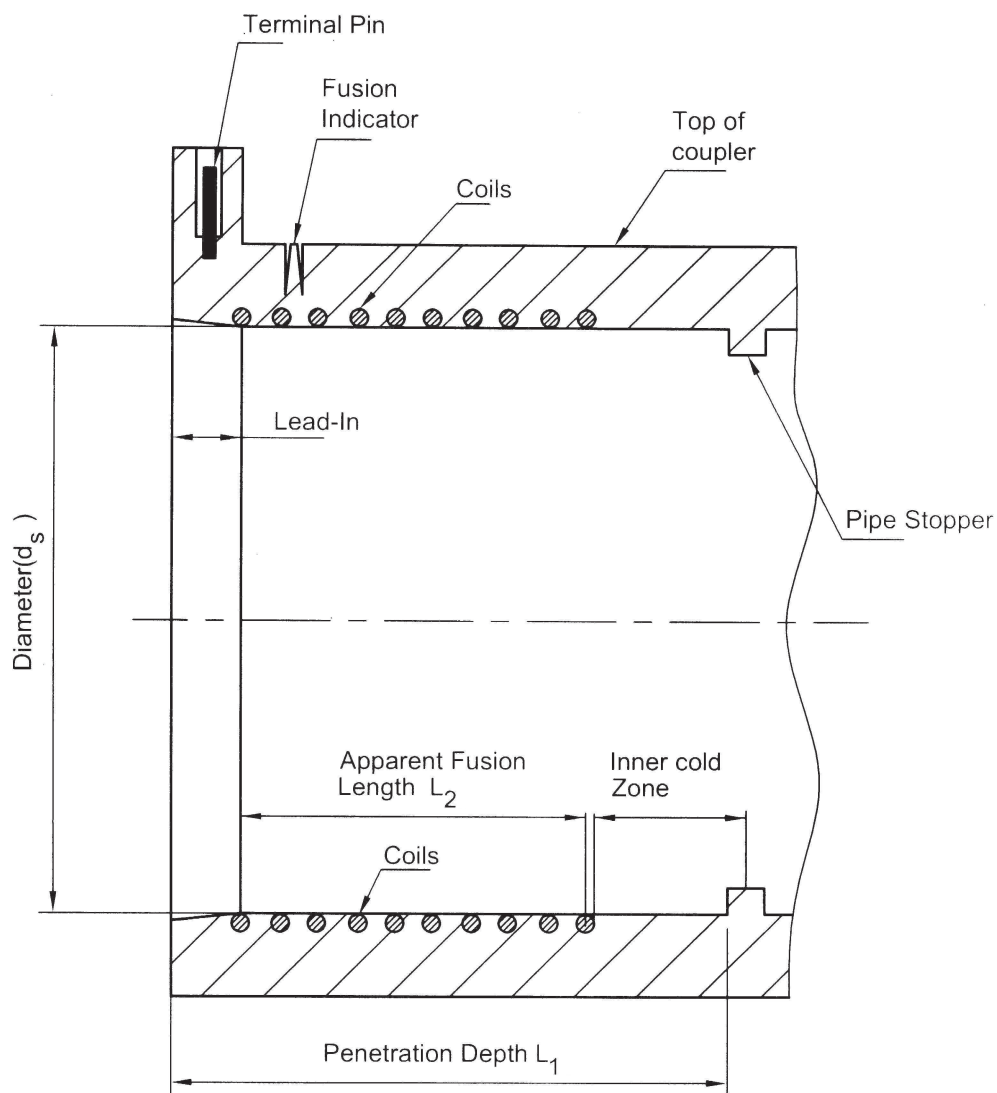
The colour of the fittings shall be yellow/black for

PE 80 and black for PE 100 fittings.

6 MATERIAL

6.1 The polyethylene compound used in the manufacture of fittings shall be polyethylene, which shall be produced by adding only those additives necessary for the manufacture and end use of fittings conforming to this standard and for their fusion jointing. It shall be free from visible water, when checked with unaided human eyes and shall comply with the requirements as specified in Table 2 of IS14885.

All additives shall be uniformly dispersed. The



1A Socket Dimensions

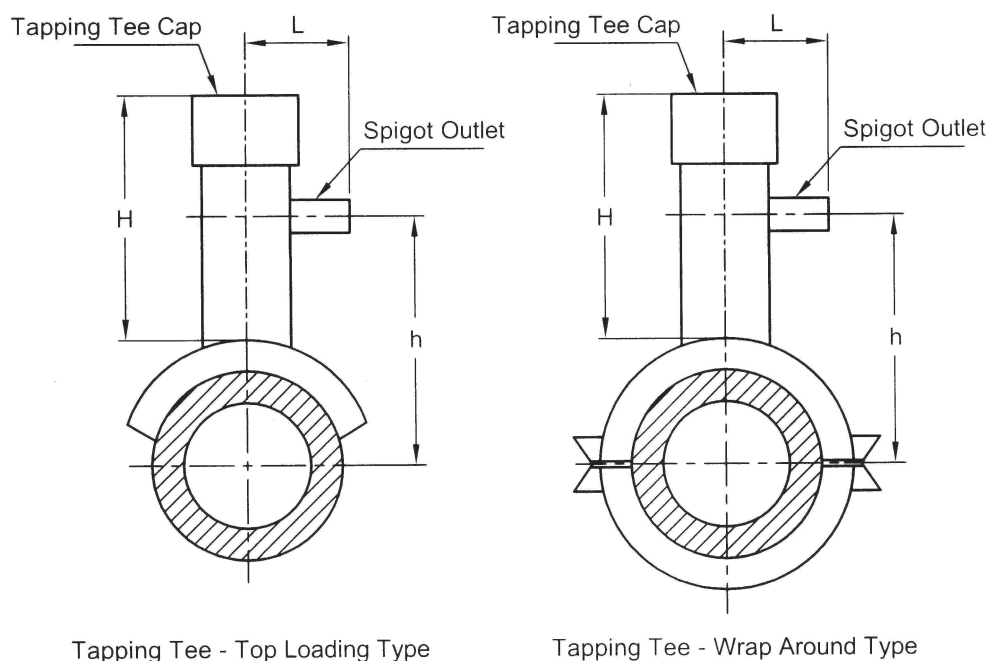
where

d_s = mean inside diameter of the socket on the fusion zone

L_1 = penetration depth

L_2 = apparent fusion zone length

FIG. 1 ELECTRO FUSION SOCKET AND TAPPING TEES (Continued)



1B Tapping Tee Dimensions

where

- h = height of the service pipe that is the distance between the axis of the main pipe and the axis of the service pipe
- L = width of the tapping tee that is the distance between the axis of the main pipe and the plane of the mouth of the spigot
- H = height of the tapping tee that is the distance from the top of the main pipe to the top of the tapping tee

FIG. 1 ELECTRO FUSION SOCKET AND TAPPING TEES

additives shall not have a negative influence on the performance with respect to fusibility.

6.2 Anti-Oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin as per IS 2530.

6.3 U.V. Stabilizer

The percentage of U.V. stabilizer used shall not be more than 0.5 percent by mass of finished resin.

6.4 Carbon Black Content (for Black Compounds Only)

When tested, in accordance with IS 2530, the carbon black content shall be within 2.5 ± 0.5 percent.

6.5 Carbon Black Dispersion (for Black Compounds Only)

When tested, in accordance with IS 2530, the dispersion of carbon black shall be satisfactory.

6.6 Pigment Dispersion (for Non-black Compounds Only)

When tested as per 5.4 of IS 14885, the grading should be ≤ 3 .

6.7 Effects of Gas Constituents on the Hydrostatic Strength

When tested as per 5.5 of IS 14885, the fitting shall pass the test.

6.8 Compatibility

Conformity to 10 shall be established by the fitting manufacturer to ensure compatibility of the fittings with PE pipes conforming to IS 14885. The PE pipe used for this demonstration, the fusion conditions and the tooling shall be as detailed in Annex A.

Fittings shall be suitable for jointing to pipe with SDR values as specified in Table 1.

6.9 Corrosion Resistance

All exposed metallic components in the electrical

terminal connections of the fitting shall be corrosion resistant or suitably protected against corrosion. This shall be demonstrated by immersing the fitting for seven days at $27 \pm 2^\circ\text{C}$ in an aqueous sodium chloride solution (30 g/l), after which there shall be no evidence of rust spots.

6.10 Elastomeric (rubber) seals shall conform to IS 15430.

Table 1 Fitting Grades and Connecting Pipe SDR
(Clause 6.8)

Sl No.	Fitting Grade	Pipe Diameter Range mm (3)	SDR of Fitting (4)	SDR of Pipe (5)
(1)	(2)	(3)	(4)	(5)
i)	PE 80	$20 \leq d_n < 50$	11	11
		$50 \leq d_n < 315$	11	11, 13.6, 17.6
		$50 \leq d_n < 315$	17.6	17.6
ii)	PE 100	$20 \leq d_n \leq 315$	11	11, 13.6, 17.6

NOTES

1 PE 100 fittings can be used with PE 80 pipes, without change in fusion time.

2 Fittings of SDR 11 and SDR 17.6 only are normally used for gas distribution systems. Therefore, only SDR 11 and SDR 17.6 electro fusion fittings have been covered in this standard.

7 GENERAL REQUIREMENTS

7.1 Appearance of the Fitting

Fittings shall be free from cracks, voids, blisters, distortion, dents or defects likely to impair their performance.

7.2 For a given type of fitting the fusion time shall be same, irrespective of pipe SDR on to which it is to be fused. However, the fusion time for different types and sizes of fittings shall be as declared by the manufacturer.

7.3 Fusion Indicator (One per Fusion Zone)

A fusion indicator is a permanent and obvious means of showing that the joint has been subjected to the fusion cycle and which shall be provided on the external surface of the fitting. Typically the fusion indicators must pop up during fusion cycle to indicate that the fitting is subjected to the fusion cycle.

7.4 Appearance of the Joint

Except for the fusion indicators, melt from the fusion operation shall not exude (spillover) outside the fitting or into the inner cold zone of the fitting.

The fusion process shall not create significant voids on the fusion interface or promote pipe collapse.

7.5 Joint Reheating

Each fitting designed for use on SDR 11 and SDR 17.6

pipe shall be capable of one reheat under assembly conditions for the full fusion cycle time without deterioration of the fusion joint. The fitting shall be allowed to cool to $27 \pm 2^\circ\text{C}$ prior to reheating cycle.

8 ELECTRICAL REQUIREMENTS

8.1 Power Input

The maximum power requirement for socket fitting up to and including 280 mm and all saddle fittings shall be 2.5 kW at 40 V rms. The maximum power requirement for socket size 315 mm shall be 4 kW at 40 V rms.

The fitting voltage supply shall be 39 V to 40 V rms.

8.2 Heating Element Resistance

For each size and type of the fitting, the manufacturer shall declare the nominal resistance of the heating element and specify the tolerances. The tolerance of the resistance should not be more than ± 10 percent.

The manufacturer shall demonstrate that a satisfactory joint can be made using the extremes of these tolerances using the method specified in Annex B.

8.3 Short/Open Circuit

The heating element shall be suitably designed to prevent short circuiting or local over heating during the fusion operation. Protective coatings applied to the heating element shall not have a detrimental effect on the joint.

8.4 Terminal Design

All fittings shall have mechanically shrouded male electrical terminals. The shroud shall be designed so as to minimize the potential for impact damage.

Fitting terminals and shroud shall comply with either Fig. 2A or Fig. 2B. The terminal pin material shall be corrosion resistant.

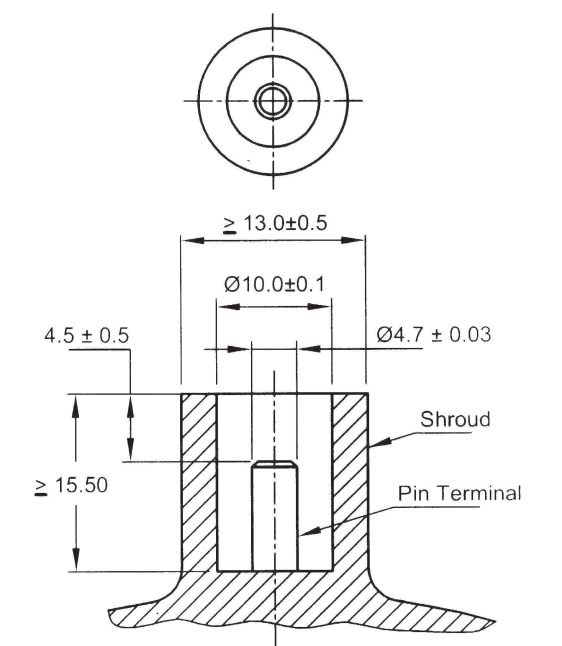
8.5 Jointing Time

Jointing time includes fusion time and cooling time. The cooling time for each fitting shall be determined using the method specified in Annex C. The maximum cooling time for fitting shall be as declared by the manufacturer.

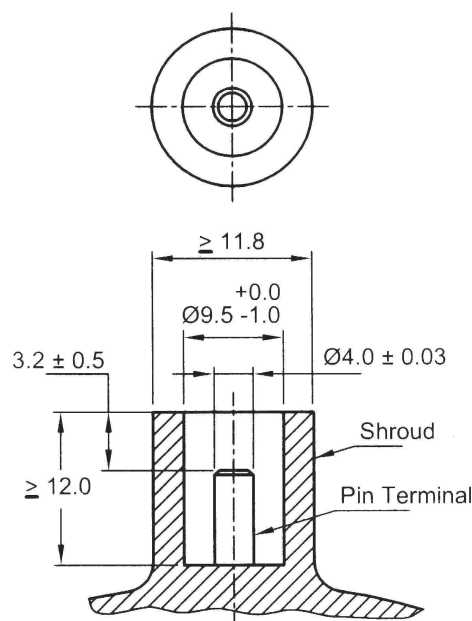
9 GEOMETRICAL CHARACTERISTICS

The nominal diameter of fittings covered in this standard are 16, 20, 25, 32, 40, 50, 63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280 and 315 mm.

All measurements on the fittings shall be taken after 24 h of manufacture.



2A Terminal (Connector Socket) Arrangement for 40 V System



2B Terminal (Connector Socket) Arrangement for 40 V System

FIG. 2 TERMINAL ARRANGEMENT

The wall thickness E of the fitting corresponding to a particular SDR rating for production shall be in accordance with Table 4 of IS 14885.

Fittings and associated fusion joints shall meet the requirements for mechanical characteristics given in 11.

Any changes in wall thickness inside the body of the fitting shall be gradual in order to prevent stress concentrations.

9.1 Relationship Between Fitting and Pipe Wall Thickness

Wall thickness of the fitting E shall,

- be $\geq$ the minimum wall thickness of the corresponding pipe $e_{\min}$ at every part of the fitting located at a distance beyond $2L_f/3$ from any entrance face of the fitting, when the fitting and the corresponding pipe belong to the same MRS, and
- conform to Table 2 when the fitting and the corresponding pipe do not belong to the same MRS classification.

Table 2 Relationship Between Fitting and Pipe Wall Thickness

Sl No.	Pipe and Fitting Material		Relationship Between Fitting (E) and Pipe (e_n) Wall Thickness
(1)	Pipe (2)	Fitting (3)	(4)
i)	PE 80	PE 100	$E \geq 0.8 e_n$
ii)	PE 100	PE 80	$E \geq e_n / 0.8$

9.2 Couplers

Socket fitting shall be provided with a lead in to ease joint assembly (see Fig. 1A).

For socket sizes ≥ 250 mm, means shall be provided to facilitate site handling and to protect fusion surfaces from handling damage.

Ovality within the internal diameter (d_{in}) of socket fittings shall not be greater than $0.015 d$ where d is the nominal size of the fitting.

Straight couplers shall incorporate a method of controlling pipe penetration within each socket. The inner cold zone of each socket shall not be less than $(0.1d + 5)$ mm for sizes up to 125 mm and $(0.1d)$ for sizes greater than 125 mm, where d is the nominal size of the socket.

Coupler dimensions shall conform to Table 3 as shown in Fig. 1A. Internal diameter, minimum apparent fusion length and maximum penetration depth, total length of couplers shall conform to the dimensions given in Table 3 and as shown in Fig. 1A.

9.3 Reducers

The overall length shall be as given in Table 4. Other dimensions shall conform to Table 3. In order to minimize the pressure drop, there shall be no sudden step changes of internal diameter. The inner cold zone of each socket as specified in 9.2.

Table 3 Socket Dimensions (see Fig. 1A)
(Clauses 9.2 and 9.3)

All dimensions in millimetres.

Sl No.	Pipe Size d_n	Apparent Fusion Length L_2	Penetration Depth L_1	
			Min	Max
(1)	(2)	(3)	(4)	(5)
i)	16	10	25	41
ii)	20	10	25	41
iii)	25	10	25	41
iv)	32	10	25	44
v)	40	10	25	49
vi)	50	10	28	55
vii)	63	11	31	63
viii)	75	12	35	70
ix)	90	13	40	79
x)	110	15	53	82
xi)	125	16	58	87
xii)	140	18	62	92
xiii)	160	20	68	98
xiv)	180	21	74	105
xv)	200	23	80	112
xvi)	225	26	88	120
xvii)	250	33	95	129
xviii)	280	35	104	139
xix)	315	39	115	150

NOTES

1 d_n is the mean bore diameter of the socket as measured along the apparent fusion length L_2 .

2 The overall length of a straight coupler shall be equal to twice the maximum penetration depth L_1 .

3 The apparent fusion zone length L_2 is the length of integral heating element from the first regular section of the element to the end of the regular section on one side of the fitting. This dimension to be measured from the outside edge to out side of the wire.

4 At present, nominal sizes of socket fittings covered are up to 315 mm only, as gas distribution mains in India are only up to this diameter.

The smaller socket shall incorporate a method of avoiding over penetration of the pipe beyond the penetration depth specified in Table 3, into the larger socket by means of a pipe stopper.

9.4 Electro Fusion Tapping Tee

9.4.1 The manufacturer shall specify the overall dimensions of the tapping tees as shown in Fig. 1B.

These dimensions shall include, h , L and H (see 4.2).

The outlet of the tapping tee shall be either spigot type or electro fusion type. The dimensions of the spigot part of the tapping tee shall be as per Table 5.

9.5 Electro Fusion Saddle Fittings

Outlets from tapping tees and branch saddles shall have spigots conforming to IS 15927 (Part 2) or sockets conforming to IS 15927 (Part 3).

Table 4 Overall Length of Reducers
(Clause 9.3)

All dimensions in millimetres.

Sl No.	Major Diameter	Maximum Length
(1)	(2)	(3)
i)	20	82
ii)	25	90
iii)	32	90
iv)	40	110
v)	50	110
vi)	63	120
vii)	75	125
viii)	90	180
ix)	110	215
x)	125	215
xi)	140	280
xii)	160	280
xiii)	180	280
xiv)	200	245
xv)	225	260
xvi)	250	280
xvii)	280	300
xviii)	315	320

Table 5 Dimensions for Spigot Outlet of Electro Fusion Tapping Tees (see Fig. 1B)
(Clause 9.4.1)

All dimensions in millimetres.

Sl No.	Outer Diameter of Spigot	Minimum Spigot Length	Minimum Spigot Wall Thickness
(1)	(2)	(3)	(4)
i)	20 ^{+0.3} ₋₀	60	As per Table 4 of IS 14885
ii)	25 ^{+0.3} ₋₀	65	As per Table 4 of IS 14885
iii)	32 ^{+0.3} ₋₀	75	As per Table 4 of IS 14885
iv)	63 ^{+0.3} ₋₀	75	As per Table 4 of IS 14885

Overall dimensions of the fittings such as the maximum height of the saddle, H and for tapping tees the height of the service pipe, h shall be as agreed to between the manufacturer and the buyer.

9.6 Electro Fusion End Cap Assemblies

Electro fusion end cap assemblies typically consist of a straight coupler conforming to 9.2 with a spigot end cap conforming to IS 15927 (Part 2), assembled and securely retained in such a way that they do not easily separate prior to electro fusion.

10 PERFORMANCE REQUIREMENTS

10.1 General

Jointed pipe and fitting assemblies shall be prepared in accordance with Annex A and shall comply with the performance requirements as per 10.

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Fittings shall be used as per MAOP values given in 3.8, with a minimum *C* factor of 2.9.

10.2 Melt Flow Rate (MFR)

Melt flow rate of the material taken from the fitting, when tested as per IS 2530 at 190°C with nominal load of 5 kgf and when tested from a composite sample of three fittings shall not differ by more than 30 percent from the values specified by the raw material manufacturer.

The change of MFR by processing that is the difference between the measured value for material from the fitting and the measured value from the raw material shall not be more than 25 percent.

10.3 Density

When tested as per Annex A of IS 7328 it shall meet the requirements as given in Table 2 of IS 14885.

10.4 Thermal Stability

The minimum oxidation induction time (OIT) of the material from the fitting shall be ≥ 20 min when tested as per Annex D of IS 14885.

10.5 Volatile Matter Content

When tested in accordance with Annex H of IS 14885, the value of volatile matter content shall be ≤ 350 mg/kg.

10.6 Decohesion Test

10.6.1 Decohesion Crush Test

The decohesion crush test of the fusion joints of socket fittings ≥ 90 mm and all electro fusion tapping tee and branch saddles shall be carried out in accordance with Annex D. No cracking shall occur at the fusion interface during the test period of 10 min. End effects over the first two complete turns of wire shall be ignored.

10.6.2 Decohesion Peel Test

A decohesion peel test of the fusion joints of socket fittings ≥ 90 mm shall be carried out in accordance with Annex E. The tear along the fusion lengths shall be ductile over a minimum length of 66.6 percent of the apparent fusion length.

10.7 Hydraulic Characteristics

A fitting joint assembly prepared as per Annex A, when tested in accordance with the procedure described in Annex A of IS 14885 shall conform to the requirements given in Table 6.

10.8 Branch Saddle Fusion Pull-off Test

A branch saddle joint assembly, when tested in accordance with Annex F shall not fail.

10.9 Electro Fusion Tapping Tee Impact Strength Test

An electro fusion tapping tee when tested in accordance with Annex G, shall withstand an impact-energy of 100 J without failure.

10.10 End Reversion Test

Spigot end when subjected to reversion test in accordance with Annex C of IS 15927 (Part 2) shall satisfy:

- All specimen shall have a diameter within the range specified in IS 14885; and
- Joint strength test shall be satisfactory.

10.11 Electro Fusion Tapping Tee; Cap Leakage Test

An electro fusion tapping tee cap when tested in accordance with method given in Annex H shall not leak.

10.12 Tapping Tee; Pressure Drop Test

The pressure drop shall not exceed the values given in Table 8, for the appropriate air flow at a working pressure of 25 mbar. The test is specified in Annex J.

10.13 Resistance to Tensile Load

An electro fusion joint when tested in accordance with method given in Annex K shall not fail.

11 ACCEPTANCE TESTS

Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of the batch. Samples for acceptance tests shall be prepared as per the conditions given in Table 12.

11.1 Lot

For moulded fittings a lot shall be defined as the production of a machine from the time it commences to produce fittings complying with this standard until the machine is closed down.

A production lot shall not exceed either 170 h or 10 000 components, whichever is less.

For ascertaining conformity of the lot requirements of this standard the number of samples shall be selected in accordance with the provisions as mentioned under Table 9. Test samples shall be prepared as per the conditions mentioned in Table 12 and tested for compliance. When a lot acceptance is carried out the sampling plans shall be as per Table 10 and Table 11.

The number of fittings to be selected from each lot shall depend on the size of the lot and shall be in accordance with col 2 and 3 of Table 10. Each fitting so selected shall be examined for proper workmanship, appearance and dimensional requirements. Any fitting

Table 6 Hydraulic Pressure Test Characteristics
(Clause 10.7)

SI No.	Property	Requirement	Test Parameters	Method of Test, Ref to Annex of IS 14885
(1)	(2)	(3)	(4)	(5)
i)	Acceptance test at 20°C, h	Failure time ≥ 100	a) End caps orientation : Not applicable b) Conditioning time : 1 h c) Type of test : Water-in-water d) Pressure calculated to produce the following circumferential (hoop) stress: 1) PE 80 pipe : 10 MPa 2) PE 100 pipe : 12.4 MPa 3) Test temperature : $20 \pm 1^\circ\text{C}$	A
ii)	Acceptance test at 80°C, h	Failure time ≥ 165	a) End caps orientation : Not applicable b) Conditioning time : 12 h c) Type of test : Water-in-water d) Pressure calculated to produce the following circumferential (hoop) stress: 1) PE 80 pipe : 4.6 MPa 2) PE 100 pipe : 5.5 MPa 3) Test temperature : $80 \pm 1^\circ\text{C}$	A
iii)	Type test at 80°C, h	Failure time $\geq 1\ 000$	a) End caps orientation : Not applicable b) Conditioning time : 12 h c) Type of test : Water-in-water d) Pressure calculated to produce the following circumferential (hoop) stress: 1) PE 80 pipe : 4 MPa 2) PE 100 pipe : 5 MPa 3) Test temperature : $80 \pm 1^\circ\text{C}$	A

NOTE — For hydrostatic strength test at 80°C, only brittle failure shall be taken in to account. If ductile failure occurs before the required time, a lower stress shall be selected and the minimum test time shall be obtained from Table 7.

Table 7 Hydrostatic Strength (80°C) — Stress/Minimum Failure Time Correlation
(Table 6)

SI No.	Stress MPa	Minimum Failure Time h	Stress MPa	Minimum Failure Time h
	PE 80		PE 100	
(1)	(2)	(3)	(4)	(5)
i)	4.6	165	5.5	165
ii)	4.5	219	5.4	233
iii)	4.4	293	5.3	332
iv)	4.3	394	5.2	476
v)	4.2	533	5.1	688
vi)	4.1	727	5.0	1 000
vii)	4.0	1 000	—	—

NOTE — In the event of modification of the fusion jointing parameters, the manufacturer shall ensure that the joint conforms to requirements of 10.7.

Table 8 Pressure Drop Through Electro Fusion Tapping Tees
(Clause 10.12)

SI No.	Fitting Outlet (Spigot) Size mm	Mains Pipe Size mm	Flow Rate of Air m ³ /h	Maximum Pressure Drop Across Fitting m bar
(1)	(2)	(3)	(4)	(5)
i)	20	All	3	0.90
ii)	25 and 32	≤ 63	4.3	0.50
iii)	63	> 63	18	0.10

NOTE — To calculate the equivalent flow rate(s) for any other gas, for example natural gas, in cubic metres per hour, the relationship given between air flow rate and gas flow rate as given in Annex J can be used.

Table 9 Acceptance Tests
(Clause 11.1)

Sl No. (1)	Description of Test (2)	Sample Size as per Table (3)	Method of Test, Ref to (4)
i)	Visual appearance (<i>see 7.1</i>)	10	—
ii)	Dimensions (<i>see 9.2, 9.3 and 9.4</i>)	10	—
iii)	Melt flow rate (<i>see 10.2</i>)	11	IS 2530
iv)	Density (<i>see 10.3</i>)	11	Annex A of IS 7328
v)	Carbon black content (<i>see 6.4</i>)	11	IS 2530
vi)	Carbon black dispersion (<i>see 6.5</i>)	11	IS 2530
vii)	Pigment dispersion (<i>see 6.6</i>)	11	Annex E of IS 14885
viii)	Thermal stability (<i>see 10.4</i>)	11	Annex D of IS 14885
ix)	Operation of fusion indicator (<i>see 7.3</i>)	11	Visual examination to agreed limits
x)	Heating element resistance (<i>see 8.2</i>)	11	—
xi)	Decohesion test (<i>see 10.6.1 and 10.6.2</i>)	11	Annex D and Annex E
xii)	Hydrostatic resistance test at 20°C (<i>see 10.7</i>)	11	Annex A of IS 14885
xiii)	Hydrostatic resistance test at 80°C (<i>see 10.7</i>)	11	Annex A of IS 14885
xiv)	End reversion test for spigot outlets (<i>see 10.10</i>)	11	Annex C of IS 15927 (Part 2)

Table 10 Scale of Sampling for Visual and Dimensional Requirements
(Clause 11.1)

Sl No. (1)	No. of Fittings (2)	Sample No. (3)	Sample Size (4)	Cumulative Sample Size (5)	Acceptance No. (6)	Rejection No. (7)
i)	Up to 150	First	13	13	0	2
		Second	13	13	1	2
ii)	151-280	First	20	20	0	3
		Second	20	40	3	4
iii)	281-500	First	32	32	1	4
		Second	32	64	4	5
iv)	501-1 200	First	50	50	2	5
		Second	50	100	6	7
v)	1 201-3 200	First	80	80	3	7
		Second	80	160	8	9
vi)	3 201-10 000	First	125	125	5	9
		Second	125	250	12	13
vii)	Above 10 000	First	200	200	7	11
		Second	200	400	18	19

failing in one or more of these requirements shall be considered as defective. The lot shall be considered as conforming to requirements of this standard, if the number of defective fittings found in the first samples are less than or equal to the corresponding acceptance number given in col 6 of Table 10.

The lot shall be deemed not to have met these requirements, if the number of defective found in the first sample is greater than or equal to the corresponding rejection number given in col 7 of Table 10.

If however, the number of defective found in the First sample lies between the corresponding acceptance and rejection numbers given in col 6 and col 7 of Table 10, the second sample of the size given in col 4 of Table 10 shall be taken and examined for these requirements, if the number of defective found in the cumulative samples is less than or equal to the corresponding acceptance number given in col 6 of Table 10, otherwise not.

Table 11 Sampling Plan for Hydraulic Characteristics, MFR, Thermal Stability and Joint Hydrostatic Strength
(Clause 11.1)

Sl No. (1)	No. of Fittings (2)	Sample Size (3)
i)	Up to 800	3
ii)	801-1 600	4
iii)	1 601-2 400	5
iv)	2 401-3 200	6
v)	Above 3 200	7

12 TYPE TESTS

12.1 Type tests are intended to prove the suitability and performance of a new composition, a new technique or new size of fitting. Such tests, therefore need to be applied only when a change is made in composition or method of manufacturing or a new size of a fitting is to be introduced.

12.2 Samples of the same pressure class fittings and same size should be selected at random for each type test and shall be tested for compliance with the requirements as indicated against each test as shown in Table 13. Test samples shall be prepared as per the conditions mentioned in Table 12.

Table 12 Preparation of Test Assemblies — Conditions
(Clause 11.1 and 12.2)

Sl No.	Nominal Temperature Before Fusion, °C		Applied Voltage	Saddle Fitting Force	Pipe SDR
	Pipe	Fitting	(see Annex B)	N	
(1)	(2)	(3)	V (4)	(5)	(6)
i)	–5	–5	Minimum	1 000	11
ii)	23	23	Maximum	1 500	17.6
iii)	–5	23	Maximum	1 500	17.6

13 MARKING

13.1 All fittings shall be indelibly marked using characters of minimum 3 mm height for sizes $d_n \leq 90$ mm and minimum 5 mm height for sizes $d_n > 90$ mm.

13.2 The following information shall be given on the fitting:

- Manufacturer's identity,
- Nominal diameter and SDR rating,
- Date of manufacture or batch No.,
- Fusion time, in s,
- Cooling time, in min, and
- Material (PE + Designation).

13.2.1 All fittings shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failures.

13.2.2 If printing is used the colour of the printed information shall differ from the basic colour of the product.

13.2.3 The marking shall be such that it is legible without magnification.

13.2.4 Any additional information (such as barcode) may be printed on a label associated with the fitting.

13.3 All marking shall remain legible under normal handling, storage and installation procedures. The method of marking shall not prevent the fitting from meeting the requirements of this standard.

13.4 BIS Certification Marking

The fittings may also be marked with the Standard Mark.

13.4.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

14 PACKAGING OF FITTINGS

14.1 The heating elements of tapping tees and branch saddles shall be protected by a shield which should remain in place during normal handling.

14.2 Electrical terminals shall be protected by a removable cap.

14.3 Fittings shall be individually packed in transparent polyethylene or equivalent bags of at least 75 μ thickness in order to prevent deterioration. The outer pack shall be suitable for stacked storage and be marked with the information required in 13.2 (a), (b) and (c) together with fitting type and quantity in the pack. They shall be packed appropriately in cardboard boxes or cartons.

Table 13 Type Tests
(Clause 12)

Sl No.	Description of Test	Sample Size	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Volatile matter content (see 10.5)	3	Annex H of IS 14885
ii)	Operation of fusion indicator (see 7.3)	3	Visual examination to agreed limits
iii)	Heating element resistance (see 8.2)	3	—
iv)	Decohesion test (see 10.6.1 and 10.6.2)	3	Annex D and Annex E
v)	Hydrostatic resistance test at 80°C (see 10.7)	3	Annex A of IS 14885
vi)	End reversion test for spigot outlets (see 10.10)	3	Annex C of IS 15927 (Part 2)
vii)	Electro fusion tapping tee cap leakage test (see 10.11)	3	Annex H
viii)	Electro fusion tapping tee impact test (see 10.9)	3	Annex G
ix)	Electro fusion tapping tee pressure drop test (see 10.12)	3	Annex J
x)	Resistance to tensile load (see 10.13)	3	Annex K
xi)	Branch saddle pull-off test (see 10.8)	3	Annex F
xii)	Effects of gas constituents on the hydrostatic strength (see 6.7)	3	5.5 of IS 14885

ANNEX A

(Clauses 6.8, 10.1 and 10.7)

PREPARATION OF TEST ASSEMBLIES

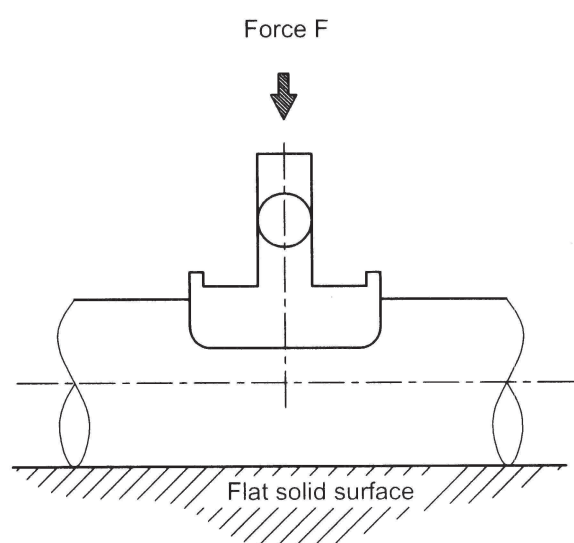
A-1 ASSEMBLY COMPONENTS

For testing, pipe conforming to IS 14885 shall be used. In case of type testing, pipe from coils should be used for sizes ≤ 125 mm. For acceptance testing straight pipe may be used.

A-2 TEST ASSEMBLY

The preparation and assembly of test samples shall be carried out using appropriate tooling, except for approval testing of tapping tees and branch saddles which shall be assembled as shown in Fig. 3. For the fittings where the force is not reacted through the stack, alternative assembly techniques shall be used.

Prior to fusion, pipes and fittings shall be conditioned in environment maintained at a temperature of either $-5 \pm 2^\circ\text{C}$ for at least 2 h or $27 \pm 2^\circ\text{C}$ for at least 8 h. All pipe and fittings assemblies where the pipe is conditioned at -5°C shall be fused at this temperature. Where the fitting has been conditioned at $27 \pm 2^\circ\text{C}$, assembly and start of the fusion in the -5°C environment shall be completed within 2 min.



NOTE — Force 'F' is 500 N for main pipe sizes up to 50 mm and 1 500 N for main pipe sizes ≤ 63 mm.

FIG. 3 TAPPING TEE TEST SPECIMEN ASSEMBLY

Socketed fittings shall be assembled to pipe to provide a gap between the pipe ends and the pipe penetration stop of at least 0.05 times the pipe outside diameter. For approval test assembly only the pipe and fitting shall be measured to identify the maximum and minimum diameter. Assemblies shall give maximum clearance at one point and minimum clearance at another.

Where saddle fittings are fused to coiled pipe, the fittings fused with a stack load of 1 000 N shall be positioned perpendicular to the minimum diameter of the pipe. Fittings fused with a stack load of 1 500 N shall be positioned perpendicular to the maximum diameter of the pipe. The pipe shall be removed from the coil immediately prior to conditioning and the first 5 m from the coil shall not be used.

Joints shall be fused for the necessary time period using an adjustable output voltage control box. The voltage from the control box shall be adjusted to give minimum or maximum power as determined by Annex B.

Assemblies may contain more than one fitting provided that the free length of pipe between fittings of any type is not less than three times the pipe outside diameter. For electro fusion saddle assemblies the free length of pipe between fittings may not be less than twice the pipe outside diameter for all sizes, provided adjacent fittings are rotated relative to each other by not less than 90° .

Test samples for pressure test shall be closed with pressure tight end-load bearing end caps, plugs or flanges which shall be provided with connections for entry of water and release of air. Spigot may be closed without the use of electro fusion fittings.

Where assemblies contain saddle fittings with integral cutters, the main shall be cut and cutter retracted into the body of the fitting before testing. Where assemblies contain saddle fittings with a separate cutter, the main pipe shall be cut and the cutter removed before testing. Electro fusion tapping tee caps shall be tightened in accordance with **10.11**.

ANNEX B

(Clauses 8.2 and A-2)

ASSESSMENT OF FITTING RESISTANCE TOLERANCE BAND

B-1 APPARATUS

The apparatus shall consist of the following items:

- a) A 4 wire resistance bridge resistance measuring device with the following specifications as a minimum:

Range	Resolution	Accuracy
0-1 Ω	100 $\mu\Omega$	± 0.25 percent of reading
0-10 Ω	1 m Ω	
0-100 Ω	10 m Ω	

- b) A true rms voltmeter with an accuracy of at least ± 0.1 percent and a resolution of 10 mV in the 0 V to 100 V range.
- c) A temperature controlled air space which can be maintained at $-5 \pm 2^\circ\text{C}$ and $27 \pm 2^\circ\text{C}$.
- d) An adjustable output voltage control box.

B-2 PROCEDURE

B-2.1 Minimum Tolerance Value

Condition the pipe and fitting at $27 \pm 2^\circ\text{C}$.

Measure the resistance of the fitting under test (R_{27})

Calculate the applied fitting voltage from:

$$\text{Applied Voltage} = V \sqrt{\frac{R_{27}}{R_{\text{Min}}}}$$

where

R_{Min} = manufacturer's declared minimum fitting resistance, and

$$V = 40 \text{ V.}$$

Using a resistive load on the output of the control box,

set the control box output voltage to the voltage calculated as above.

Assemble and fuse the fitting to the specified fusion time.

When the joint has cooled, section the sample and check for signs of pipe collapse or creasing of the pipe bore.

Subject the sectioned sample to the decohesion test as specified in **10.6**.

B-2.2 Maximum Tolerance Value

Condition the pipe and fitting at $-5 \pm 2^\circ\text{C}$.

Measure the resistance of the fitting under test (R_{27}) at $27 \pm 2^\circ\text{C}$.

Calculate the applied fitting voltage from

$$\text{Applied Voltage} = V \sqrt{\frac{R_{27}}{R_{\text{Max}}}}$$

where

R_{Max} = manufacturer's declared maximum fitting resistance, and

$$V = 39 \text{ V.}$$

Using a resistive load on the output of the control box, set the control box output voltage to the voltage calculated as above.

Assemble and fuse the fitting to the specified fusion time.

When the joint has cooled, section the sample and check for signs of pipe collapse or creasing of the pipe bore.

Subject the sectioned sample to the decohesion test as specified in **10.6**.

ANNEX C

(Clause 8.5)

DETERMINATION OF FITTING COOLING TIME**C-1 APPARATUS**

The apparatus shall consist of the following items:

- a) A 4 wire resistance bridge resistance measuring device with the following specifications as a minimum:

Range	Resolution	Accuracy
0-1 Ω	100 $\mu\Omega$	} ± 0.25 percent of reading
0-10 Ω	1 m Ω	
0-100 Ω	10 m Ω	

- b) A true rms voltmeter with an accuracy of at least ± 0.1 percent and a resolution of 10 mV in the 0 V to 100 V range.
- c) Thermocouples suitable for operation up to 400°C connected to a temperature recording device.
- d) An adjustable output voltage control box.

C-2 TEST PIECES

Pipes and fittings shall be conditioned at a temperature of $27 \pm 2^\circ\text{C}$ for at least 8 h.

For socket fittings two thermocouples shall be positioned diametrically opposite each other and their tips are on the outside surface of the pipe. The thermocouples shall be positioned in the centre of the resulting fusion joint. One thermocouple shall be on the top of the pipe during the fusion operation. For

reducing couplers, the cooling time of both ends shall be determined.

For saddle fittings two thermocouples shall be positioned on the crown of the pipe, one either side of the outlet stack, at a position in the center of the resulting fusion joint.

C-3 PROCEDURE

Measure the resistance of the fitting under test.

Adjust the voltage of the control box to simulate maximum power in to the fitting. This can be calculated from:

$$\text{Applied Voltage} = V \sqrt{\frac{\text{Actual fitting resistance}}{\text{Minimum fitting resistance specified by the manufacturer}}}$$

where

$$V = 40 \text{ V.}$$

Energize the fitting for the required fusion time. Record the temperatures.

On switching off the power, record the time for the thermocouples to reach 110°C.

The cooling time shall be mean time for the thermocouples at one end to reach 110°C. For reducing couplers, the higher of the two cooling times shall be taken as the fitting cooling time.

ANNEX D

(Clause 10.6.1)

DECOHESION CRUSH TEST

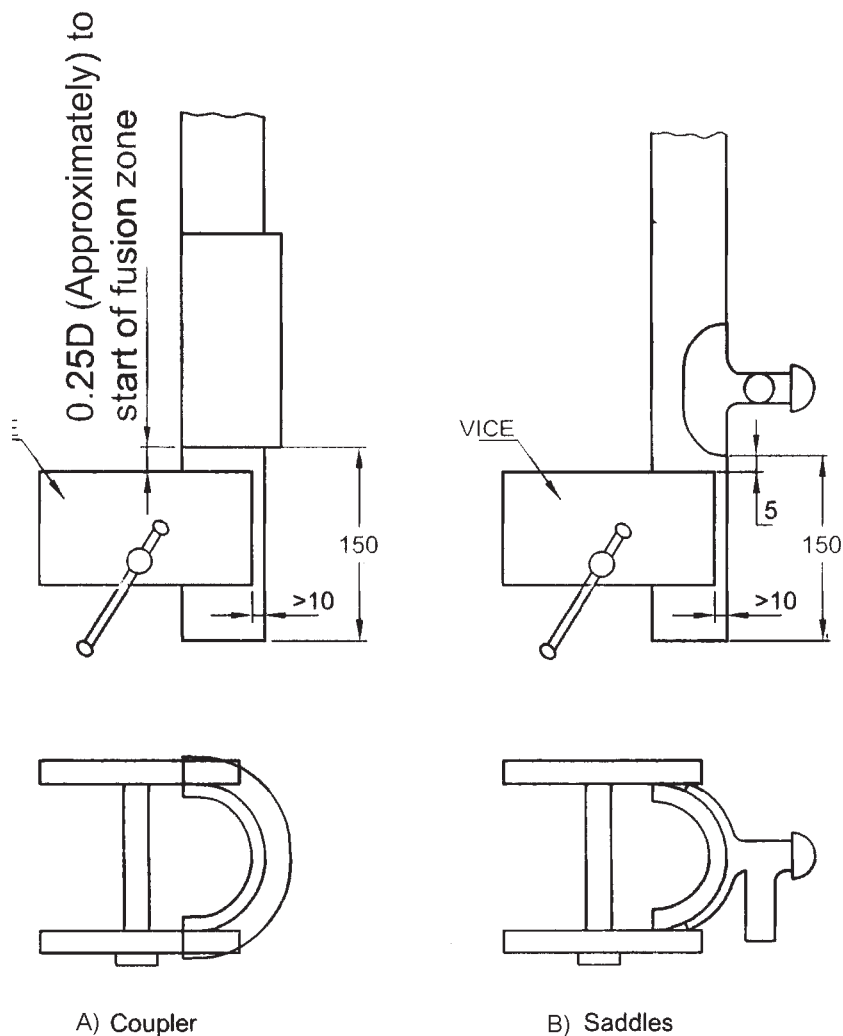
D-1 TEST PIECES

The test samples shall be prepared in accordance with Annex A using the conditions given in Table 12.

D-2 PROCEDURE

Halve the pipe and fitting along its length approximately 150 mm of pipe protruding either side

of the fitting. Hold one half of the assembly in a vice across the cut diameter as shown in Fig. 4. Squeeze the pipe in the vice until the inner pipe surfaces meet. Hold the assembly in this position for 10 min. No cracking shall occur at the fusion interfaces. End effects over the first two turns of wire shall be ignored.



All dimensions in millimetres.

FIG. 4 DECOHESION CRUSH TEST ARRANGEMENTS

ANNEX E

(Clause 10.6.2)

DECOHESION PEEL TEST

E-1 TEST PIECES

Test specimen shall consist of socketed fitting. The pipes and fittings shall be fused at minimum power input in accordance with Annex B to two lengths of pipes. The test samples shall be prepared in accordance with Annex A using the conditions given in Table 12. The pipe length shall protrude at least 125 mm either side of coupling. A fused specimen shall be sectioned at four equidistant positions around the circumference of the fitting.

E-2 PROCEDURE

Four samples of width 15 mm to 18 mm for sizes up to 90 mm or 25 mm to 30 mm for larger sizes shall be machined from four equidistant positions around the specimen. The samples shall include the maximum and minimum gap.

The samples shall be cut in half across the centre of the fitting to produce eight test pieces.

A hole of 3 mm shall be drilled through the fitting as shown in Fig. 5.

The test piece shall be fitted to the loading clamp as shown in Fig. 6. The pipe stub and the fitting-loading clamp shall be held in a tensile machine as shown in Fig. 7.

A tensile axial load shall be applied to the specimen under test at an extension speed of 25 mm/min. The test shall continue until complete separation of the pieces occurs.

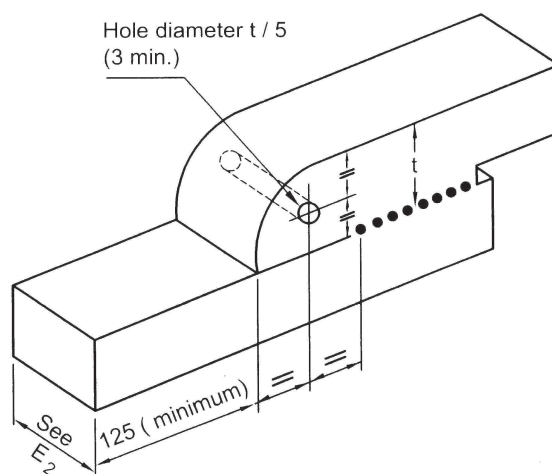
Test temperature shall be $27 \pm 2^\circ\text{C}$.

The specimen passes the test providing the 'tear' along the fusion length is ductile for at least 66.6 percent of its length.

E-3 REQUIREMENT

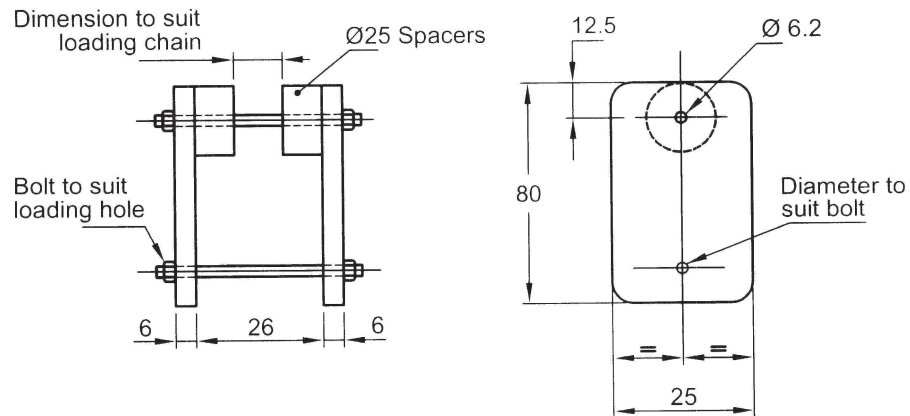
The resultant peel should be along the fusion length and be ductile in appearance as shown in Fig. 8.

A brittle or flat failure path indicates a test failure (*see* Fig. 9).



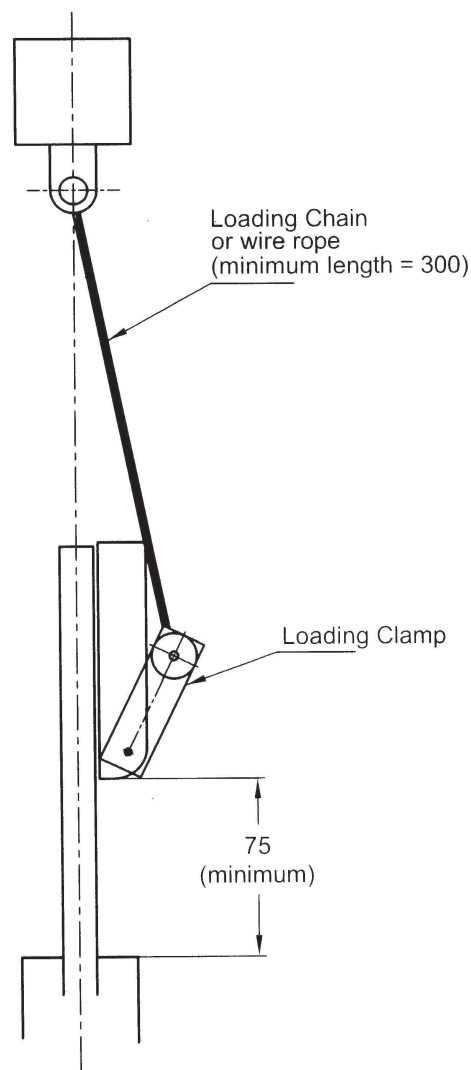
All dimensions in millimetres.

FIG. 5 TEST PIECE GEOMETRY



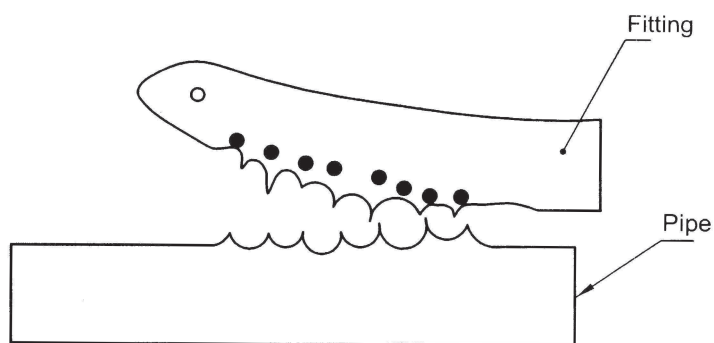
All dimensions in millimetres.

FIG. 6 LOADING CLAMP

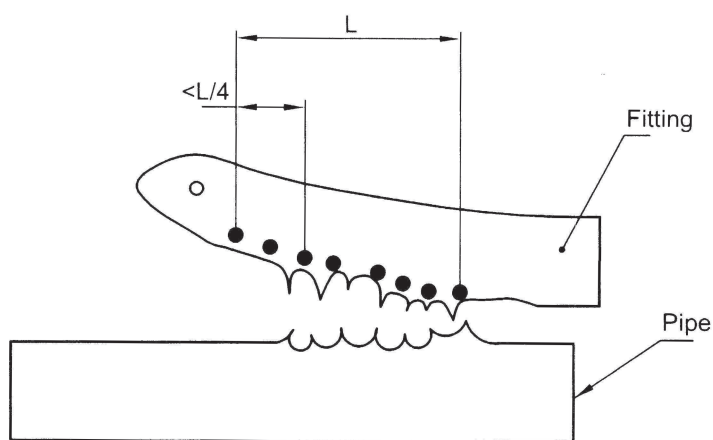


All dimensions in millimetres.

FIG. 7 DECOHESION PEEL TEST ASSEMBLY



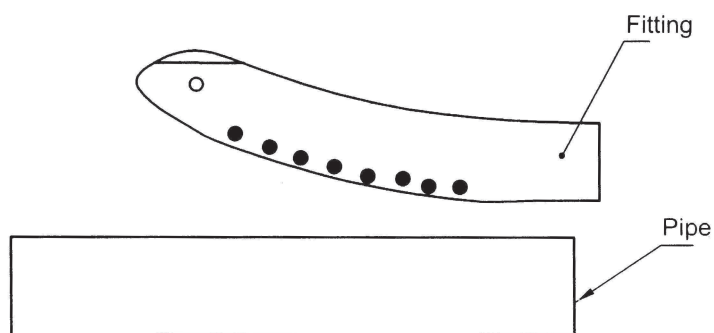
A) Typical ductile failure



B) Acceptable ductile failure

All dimensions in millimetres.

FIG. 8 TYPICAL DUCTILE FRACTURES



Surface whitening may be apparent
along failed interface

All dimensions in millimetres.

FIG. 9 UNACCEPTABLE BRITTLE FRACTURE

ANNEX F (Clause 10.8)

BRANCH SADDLE FUSION PULL-OFF TEST

F-1 TEST PIECES

Test sample shall be prepared as per Annex A. The minimum length of the pipe shall be four times the nominal spigot out let diameter.

F-2 PROCEDURE

Insert plain metal plugs in the ends of the pipes to support the pipe under the action of the loading grips.

Rigidly hold the mains pipe in a clamp with the outlet pipe vertical. The distance between the clamps shall be equal to saddle fitting width + 30 mm.

Tighten the clamps and apply the tensile load (see Fig. 10) at an extension speed of 25 ± 1 mm/min. The tensile load shall be increased till the outlet pipe or the mains pipe fails. There shall be no failure in the saddle joint fusion area, spigot out let and pipe/fitting interface.

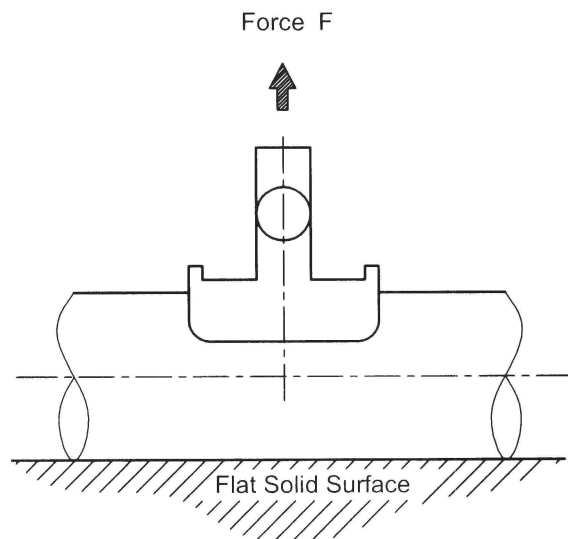


FIG. 10 BRANCH SADDLE PULL-OFF ASSEMBLY

ANNEX G (Clause 10.9)

ELECTRO FUSION TAPPING TEE IMPACT TEST

G-1 REQUIREMENTS

The electro fusion tapping tee assembly to be tested shall be held firmly against a rigid frame and so mounted that the blow will be struck normally to the surface under test. The striking head shall be arranged to give an impact energy of 100 J.

G-2 TEST PIECES

The electro fusion tapping tee to be tested shall be fused centrally to a length of pipe. The length of pipe shall be equal to three times the nominal main pipe outside diameter.

Figure 11 shows a typical impact assembly.

End plugs shall be fitted to both the ends of test piece and the test piece shall be mounted to a base plate which shall prevent the rotation of the test piece during impact.

The fusion conditions shall be as per Table 12.

G-3 PROCEDURE

The testing shall be carried out at least 24 h after fusion.

Condition the assembly at $-5 \pm 2^\circ \text{C}$ for at least 1 h prior to testing.

Testing shall be carried out at $27 \pm 2^\circ \text{C}$ and shall be completed within 5 min of removing the assembly from the conditioning chamber.

Fix the test sample to the rigid base plate.

Impact the tapping tee with the falling weight approximately 25 mm below its highest point.

The impact direction shall be parallel with the main axis. The falling weight shall strike the fitting normal to the surface under test.

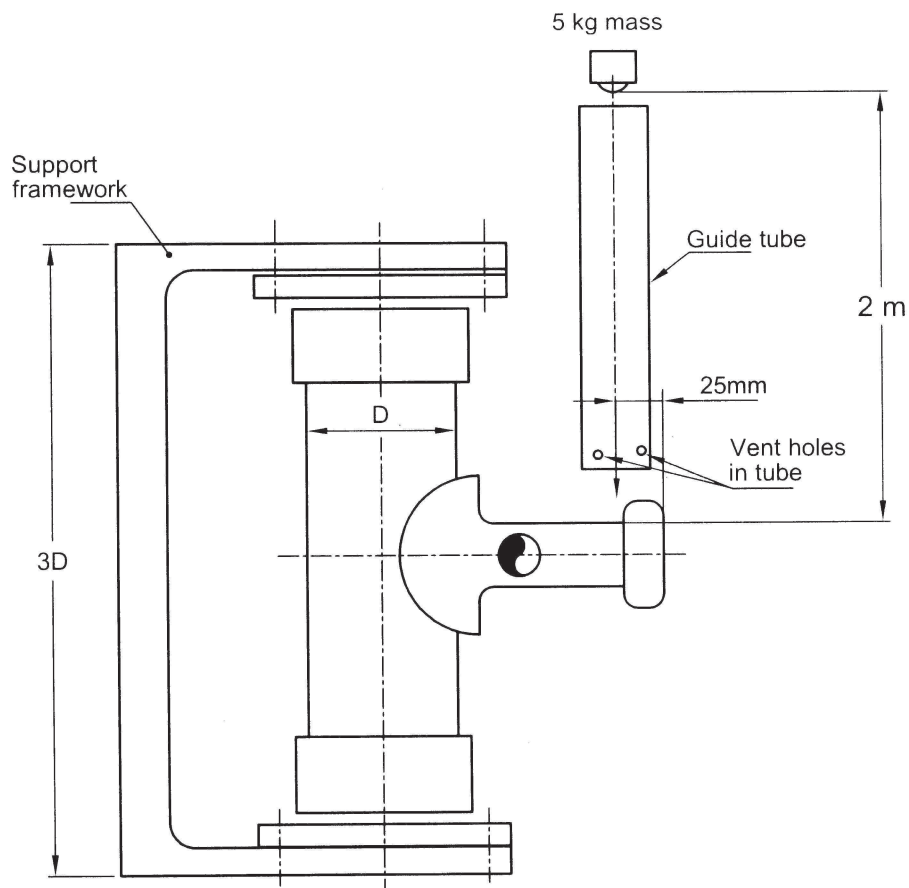


FIG. 11 TYPICAL IMPACT TEST ASSEMBLY

The falling weight shall have a mass of 5 ± 0.1 kg and a hemispherical striking face of 25 mm diameter made of hardened steel.

The weight shall be released from a height of 2 m. Turn the test sample 180° and impact the tapping tee

on the opposite face from the same position.

On completion of the test, subject the assembly to a minimum 2 bar pneumatic air pressure test for 1 h. No leakage shall occur.

ANNEX H

(Clause 10.11)

ELECTRO FUSION TAPPING TEE CAP PRESSURE LEAK TEST

H-1 APPARATUS

The apparatus shall consist of either a water bath or air chamber capable of maintaining the required temperature to within $\pm 1^\circ\text{C}$ and subjecting the specimen to the specified pressure to an accuracy of ± 2 percent. The pressurizing medium shall be water. A torque wrench shall be used to tighten the tapping tee to the specified torque to an accuracy of ± 5 percent.

H-2 TEST PIECES

The test sample shall be prepared in accordance with Annex A, except that the main shall not be cut and pressurization will be effected through the outlet.

H-3 PROCEDURE

Appropriate precautions shall be taken to provide protection to personnel, should a test sample fail under test.

Tighten the electro fusion tapping tee to a maximum torque of 4 Nm.

Maintain the test sample at a temperature of $27 \pm 3^\circ\text{C}$ through out the test.

Pressurize the test sample to 0.4 MPa and maintain this pressure within a range of ± 2 percent for a period of 2 500 h.

No leakage shall occur.

ANNEX J

(Clauses 10.12 and Table 8)

ELECTRO FUSION TAPPING TEE PRESSURE DROP TEST

J-1 This test specifies method for determining the flow rate/pressure drop relationship of electro fusion tapping tees for plastic piping systems for supply of gaseous fuels, when tested using air at 25 mbar.

The method is based on the principle that, utilizing a constant main pressure, the flow rate through a piping component is varied between specific limits to assess the pressure drop. The average value of the air flow rate for a pressure drop appropriate to the size of the component is then determined for the gas used. The value for other gases may be calculated on the basis of density differences.

The data obtained is used to calculate the flow rate of such gases for a specified pressure drop.

J-2 APPARATUS

J-2.1 The following apparatus shall be required for the tapping tee pressure drop test:

- a) Pressure controller;
- b) Flow meter;
- c) Inclined manometer (for mains pressure) — Class 0.6 or better;
- d) Inclined manometer (for differential pressure) — Class 0.25;

- e) Outlet valve; and
- f) Source of air.

J- 2.2 The apparatus shall be set up as shown in Fig. 12. The pressure controller (A) shall be capable of giving a steady output of 25 ± 5 mbar. The flow meter (B) shall be accurate to ± 2 percent and be of the positive displacement or turbine meter type.

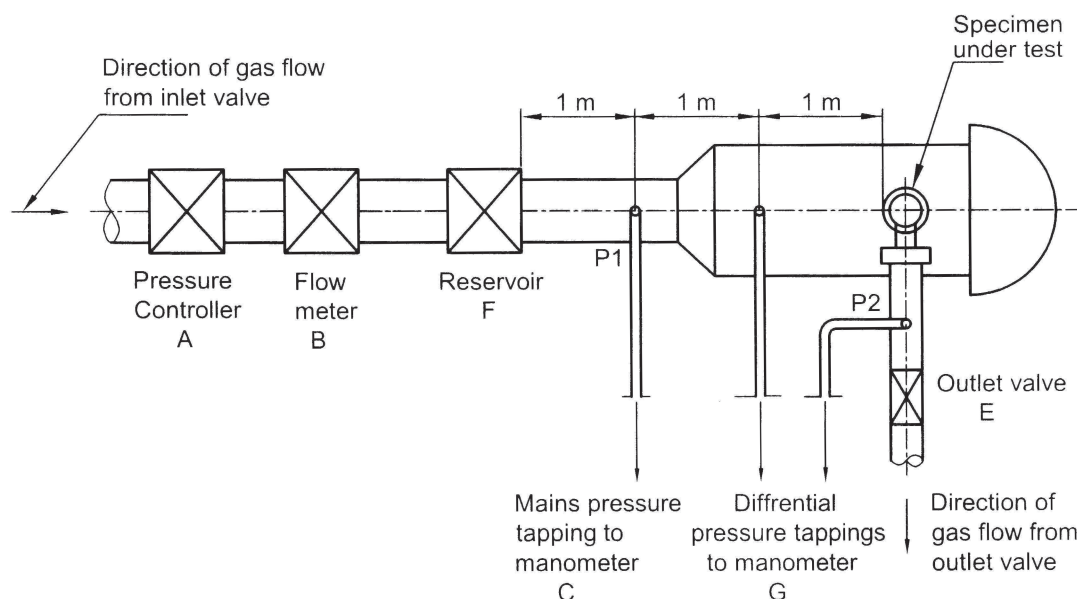
J-3 TEST SPECIMEN

The free lengths of the pipe and the geometry of the test arrangement shall be as shown in Fig. 12, so that the pressure drop can be measured through the outlet branch. The specimen shall be fused on the polyethylene pipe of the same SDR as that of component and provided with connectors appropriate to the pressure drop apparatus. Pressure tapping points upstream and downstream of the component under test shall flush with the pipe bore and free from burrs.

J-4 PROCEDURE

Testing shall be carried out at an ambient temperature of $23 \pm 2^\circ\text{C}$.

The sequence of operations for the test shall be as follows:



NOTES

- 1 Pressure tapping shall be at least $2d$ (d = relevant pipe diameter) from any fitting or valve and in the case of the tee, diametrically opposite it and upstream of it.
- 2 The flow meter shall be installed in accordance with the requirement of the device selected

FIG. 12 LAYOUT OF TEST RIG FOR TAPPING TEE PRESSURE DROP TEST

- a) Connect the inclined manometer across the tee and partially open the outlet valve (E).
- b) Open the inlet valve to the pressure regulator (A) so that gas starts to flow and check that gas flows from the outlet valve only.
- c) By means of pressure controller (A), regulate the mains pressure at point P_1 , as shown by manometer (C) to 25 ± 0.5 mbar.
- d) Measure and record the flow rate (Q) on flow meter (B) and the pressure drop (ΔP) on manometer (G).
- e) Open the outlet valve (E) sufficiently to reduce the mains pressure P_1 by approximately 5 mbar.
- f) Increase the flow rate until the mains pressure at point (C) returns to 25 ± 0.5 mbar.
- g) Measure and record the flow rate (Q) and the pressure drop (ΔP).
- h) Repeat the operations (e), (f) and (g) above until the outlet valve (E) is fully open.

J-5 CALCULATION OF RESULTS

To calculate the equivalent flow rate(s) for any other gas (for example natural gas), in m^3/h , the relationship given between air flow rate and gas flow rate is as given below:

$$Q_{\text{gas}} = Q_{\text{air}} \sqrt{\rho_{\text{air}} / \rho_{\text{gas}}}$$

where

Q_{air} = flow rate using air as test medium;

ρ_{air} = density of other air at 23°C and 1 bar; and

ρ_{gas} = density of natural gas at 23°C and 1 bar.

The procedure as specified in J- 4 gives a number of pressure drop values and the corresponding flow rate for each pressure drop.

Using each set of pressure drop values and the corresponding flow rates, calculate the following:

J-5.1 The velocity, V , of the flow, in m/s , through the outlet pipe component of the test piece using the following equation:

$$V = \frac{Q}{A}$$

where

Q = air flow rate, in m^3/h ; and

A = bore area of the outlet pipe, in m^2 .

If the following conditions are fulfilled, consider the data acceptable:

- a) At least five sets of data for Q and ΔP , and hence differing values for V have been obtained;
- b) At least one value of V is ≤ 2.5 m/s; and
- c) At least one value of V is > 7.5 m/s.

Otherwise,

- d) Adjust the inlet valve opening and repeat steps **J-4** (c) and (d) as necessary to obtain the missing values(s); and
- e) If it is not possible for V to be ≥ 7.5 m/s using a pressure of 25 ± 0.5 mbar, stop the test and report this observation.

J-5.2 The factor F for each set of readings, based on the following equation:

$$F = \frac{\Delta P}{Q^2}$$

where

ΔP = pressure drop, in mbar;

F = factor; and

Q = flow rate, in m³/h.

The factor F should be calculated for each set of readings and the average value determined.

Using the average value of F and the specified pressure drop (ΔP_n), calculate the average air flow rate (Q_a) at

that pressure drop, appropriate to the size of service fitting.

The pressure drop can also be designated in terms of number of velocity heads as explained below.

The number of velocity heads lost across the fitting should be calculated from:

$$K = \left(\frac{\Delta P}{\rho} \right) \frac{200}{V_2^2} + \left(\frac{V_1^2}{V_2^2} - 1 \right)$$

where

K = velocity head lost in the fitting based on the velocity in the service pipe;

ΔP = measured pressure drop, in mbar;

ρ = density of natural gas, kg/m³;

V_1 = velocity in main in, m/s. = Q_{nat} / A_1 ;

where

A_1 = cross sectional area of the main;

Q_{nat} = flow rate of natural gas; and

V_2 = velocity in the service pipe in, m/s = Q_{nat} / A_2 .

where

A_2 = cross-sectional area of service pipe under test.

NOTE — The equation assumes that the density effects due to velocity are negligible.

ANNEX K (Clause 10.13)

RESISTANCE TO TENSILE LOAD

K-1 PRINCIPLE

A test piece consisting of an electro fusion fitting and two connecting polyethylene pipes is subjected to an increasing tensile load at a constant pulling rate until ductile pipe failure occurs. The test is conducted at a constant temperature and is intended to simulate the creation of longitudinal tensile loading along a pipeline as a consequence of external mechanical interference.

K-2 APPARATUS

Tensile machine capable of accommodating a test piece elongation of 25 percent and sustaining constant test speed of 5 mm/min $\pm$ 25 percent.

K-3 TEST PIECE

Test sample shall be prepared as per Annex A.

K-4 PROCEDURE

Carry out the test at an ambient temperature of $27 \pm 2^\circ\text{C}$.

Hold the test piece into the grips of tensile machine. Pull the test assembly at a speed of 5 mm/min $\pm$ 25 percent until the ductile pipe failure occurs.

Check for pipe failure. Ductile failure of the pipe is acceptable. Rupture of the fitting or the connecting fusion joints is not an acceptable failure mode.

ANNEX M

(Foreword)

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In personal capacity (<i>A-59, Sector 35, Noida 201 301</i>)	SHRI KANWAR A. SINGH
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BUREAU OF INDIAN STANDARDS

Headquarters:

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Telephones : 2323 0131, 2323 3375, 2323 9402

Website: www.bis.org.in

Regional Offices:

Telephones

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
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{ 2323 7617
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